

ABSTRACT

A measurement-while-drilling or logging while drilling method and apparatus for determining the azimuth of providing magnetic field in a remote formation layer in the vicinity of a down hole resistivity tool. A cross-component magnetic field with substantially orthogonal transmitter and receiver coils is provided. The coil planes are either substantially orthogonal (coaxial coils) or parallel (transverse coils) with respect to, the longitudinal axis of the tool body. The coils are placed on the tool body having a external surface and a plurality of grooves are cut in the external surface of the tool body and oriented substantially horizontally with respect to the longitudinal axis of the tool body for the coils and oriented vertically with respect to the longitudinal axis of the tool body for the coaxial coils. A transverse and coaxial coil are placed in the grooves for transmission or reception of a cross-component transverse magnetic field. Ferrite materials may be inserted in the grooves in between the coil wire and the bottom of the grooves. Multiple receivers, transmitters and frequencies may be used to obtain the maximum possible signal-to-noise ratio. The in-phase or quadrature part of a magnetic field, or a combination of the two, or alternatively, the amplitude and/or phase, of the cross-component magnetic field may be measured and processed to indicate the azimuth of a remote layer boundary, provided that the layer boundary is within the depth of investigation of the tool. Measurements may also be made at continuous or multiple tool azimuths.